Welcome to Lecture 3. This is Lecture 3
on innate immunity, and you need to get out your outline and any
extra picture files that go with the lecture. That will help keep
down the amount of writing you have to do. In Lecture 3, we're going
to discuss innate immunity. This is the immunity that is not a result of
changes in the DNA, which we'll see is
a very unusual way to make any kind of molecule. This is the immunity that is
basically found throughout
the living world. I mean, all creatures have
some kind of innate immunity. In particular, insects have
a very interesting form of innate immunity in which while they don't
change the genes, they have a gene that they have 38,000 different ways to
splice. They use that gene again to
recognize self and non-self. Insects have innate immunity. But to make these
things, they don't change their DNA, so it's still considered
to be innate. Now, let's see, plants have even more different kinds of innate
immunity than we do. We'll see that plants have a variety of pattern
recognition receptors, of defensive peptides,
of all kinds of nasty molecules that they will produce when
they are threatened. Again, a plant is in a situation where it can't run
and it can't hide. It's only defenses are to do
a form of chemical warfare. I mentioned before that the adaptive immune
responses was a feature of the
vertebrate organisms only. Now, the vertebrates are
members of the phylum Chordata. The phylum Chordata is
mostly vertebrates, but it has a few rather
primitive, we'll say, or at least stem organisms that are similar to
those that probably gave rise to the more
complex organisms that have jaws and
backbones and skulls, and, as it turns out,
adaptive immunity. These are organisms that have
what we call a notochord. They have a spinal cord
that runs down their back. That's a dorsal spinal cord, even though it doesn't
have vertebrae around it. These organisms are considered
primitive or early, or at least representatives
of what used to be primitive or early
members of our phylum. They, of course, have
innate immunity, but they don't have
adaptive immunity. Innate immunity is something you basically find everywhere.
Adaptive immunity
is something you only find in
vertebrate organisms, that is fish, amphibians, reptiles, birds, and mammals
and we've seen that before. Our earliest cordate ancestors were filter and
detritus feeders. When you spend your life sitting at the
bottom of the ocean, sucking up whatever
drifts your way, you can see that you might
have problems with infections. It's not surprising that some fishy tunicate
descendants invented adaptive immunity
for extra protection. We're interested in us. Most mammals, birds and
reptiles are terrestrial. Their diet might not
be quite so yucky, but it still risks bringing in all sorts of threats
with their food. Also, these groups reproduce
by internal fertilization, which has its own attendant
dangers of infection. Finally, animals that live
on the land risk drying out. Let's turn to our
barrier solution. This is a drawing of skin. The skin is a complex organ that
provides
excellent protection. Few pathogens can penetrate
it and nearly all must wait for a break or an abrasion or
lesion of some kind. The upper layers
are the epidermis, the lower layers are the dermis. Epidermis has an epithelium
with the basement membrane and
living cells that divide, replace themselves and
are pushed outwards. Where they begin to die, leaving behind a

connected mesh of keratin fibers that form a
linked waterproof boundary. The dermis and epidermis constitute an organ
of great complexity. In addition to maintaining
various immune cells, the skin secretes a number
of defensive compounds. Here's the hair follicle, and notice that it's
part of the epidermis, which dips down to
cup and support it. Here's a teeny muscle that
allows you to pyloect, or have your hair stand on end. Associated with
the follicles are sebaceous glands
which secrete sebum. This is a complex
mixture of lipids. It helps to prevent water loss. It keeps the skin
slightly acidic, which discourages the growth
of bacteria and yeast. In addition to that, we have
the sweat gland down here. You can see it's in the dermis. But it has a duct
that goes up through the epidermis and secretes the sweat onto the
surface of the skin. In addition to all of that water that
helps keep you cool, there are compounds
in that sweat, things like psoriacin, which kills ecoli, dermacidin, which kills
bacteria and yeast, and various defensins that
disrupt plasma membranes. These defensins are also found
in phagocytes to disrupt plasma membranes
of bacteria that they have swallowed
by phagocytosis. Now, this is the skin that covers the outside of your body.
Inside your body,
you also have organs that exchange materials
with the outside world, and these tissues have many different structures
depending on their functions. But there are two main types. These are both types
of mucosal epithelia. That is they're going
to be secreting mucus. This one is a ciliated
mucosal lining, and at the lumen of
the small intestine, we have one that has microvilli. We've got basically
two different kinds of things sticking out. The cilia, and here's a electron
micrograph of the cilia, and that would be
this part here. These are made up of plasma membrane with
internal microtubules, those are microtubules
that they're the same microtubules
that are found in all kinds of other
eukaryotic structures like flagella and sperm tails, and a number of motor
proteins. They sweep out debris and
keep the surfaces clear. The mucus helps protect
the surface from danger, keeps it hydrated, and
also tracks that debris, so it's easier to remove. Over here, we have the
surface of your intestines, and they're lined
with microvilli. Here I have a drawing
of one of the cells in there enlarged so that
you can see the microvilli, and you can see that
they're sticking out into the lumen of the small intestine
where food is digested. If you look, you can see the microfilaments
from the cytoskeleton, extend up into each projection, and those microvilli have
actin microfilaments in them and they will move
around to improve their absorption of
sugar and amino acids. Also notice actin is one of your important motor
proteins in muscle. But this actin is a version specifically designed
for microvilli. I pointed out that both of
these epithelia make mucus. What's in that mucus? Here we have a cell in the
small intestine
of one of the villi, and we have an arrow
pointing to a goblet cell, which is making and secreting that mucus into the
small intestine. The mucus is a mixture
of different compounds, including mucin,
which is an acidic, complex carbohydrate that
forms protective gels. It's the stuff that makes
snot snotty and sputum gooey. This prevents the epithelial
surface from drying out. It reduces mechanical damage as food or dirt moves over

them. It makes it harder for worms
to attach to the epithelia, and it helps maintain
an acidic environment. Although it may also
protect the cells from too much acid
as in the stomach, and that's where your
acid is so strong, you might need a little
bit of extra coverage. The mucus also
contains lysozyme. We mentioned this before. It's a hydrolytic enzyme that
attacks bacterial walls. There's also lactoferrin, which is both a bacterioside
and a funguside. Again, hydrochloric
acid in the stomach, and I know I'm supposed to
be talking about mammals, but I cannot risk bringing
in vultures at this point. These vultures are
really impressive. They are important
members of ecosystems. They make life better
for all of us by eating carrion before the corpses and flies can spread
much disease. Now, if you know about their eating habits,
they may give you pause. There is a reason they don't have feathers on their
heads, but they can consume
and digest carcasses with botulism, anthrax, cholera. They have commensal
bacteria clusidium, and others that would kill us, but these nevertheless live
happily in their guts, helping in the
clean-up operations. Three cheers for vultures. They make your life safer, and
they illustrate
important principles of how any organisms innate
immune system is adapted to their role, their diet, and other
environmental challenges. Finally, just in passing, I want to mention that IGA,
a particular antibody designed to be secreted across epithelia is something that
we
will discuss later when we do a more detailed
study of antibodies, their differences, and
their different functions.